



Free Monthly Webinar Series:

Challenges and Treatment Solutions for Small Drinking Water Systems

Hosted by EPA's Office of Research and Development (ORD) and Office of Water (OW)

Schedule & Recordings: epa.gov/water-research/small-systems-monthly-webinar-series



October 30, 2018, 2:00-3:30 pm ET (Optional Q&A session from 3:30-4:00)

TODAY'S TOPIC:

Per- and Polyfluoroalkyl Substances (PFAS)

A certificate for one continuing education contact hour will be offered for this webinar.

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Small Systems Monthly Webinar Series (2:00-3:00 pm ET, optional Q&A session from 3:00-3:30 pm ET)

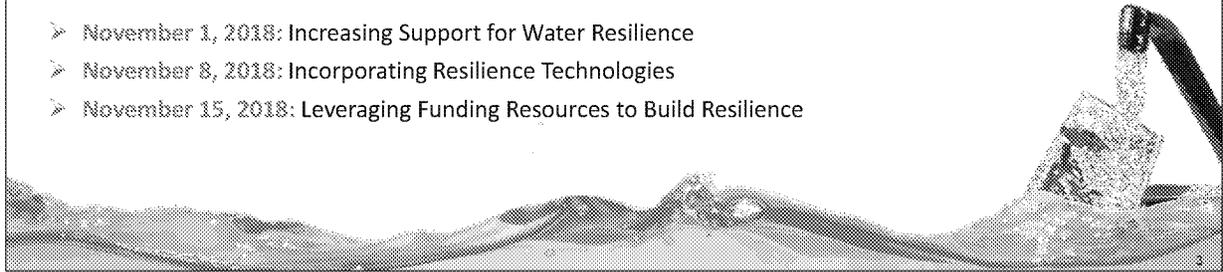
Webinar Schedule and Recordings: <https://www.epa.gov/water-research/small-systems-monthly-webinar-series>

- November 27, 2018: Tribal and Very Small Systems (registration coming soon)

Investing in Infrastructure Resilience Webinar Series (1:00-2:00 pm ET)

Registration: <https://www.eventbrite.com/e/investing-in-infrastructure-resilience-webinar-series-registration-46192473933>

- November 1, 2018: Increasing Support for Water Resilience
- November 8, 2018: Incorporating Resilience Technologies
- November 15, 2018: Leveraging Funding Resources to Build Resilience



Learn about activities, technology and funding opportunities that will help drinking water and wastewater utilities increase investment in building resilience



Disclaimer

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EPA's Ongoing Efforts to Address PFAS

This presentation will discuss key EPA activities related to PFAS management in drinking water.

Ryan Albert (albert.ryan@epa.gov)

Ryan is the Acting Chief of the Standards and Risk Reduction Branch (SRRB) in EPA's Office of Groundwater and Drinking Water. SRRB is responsible for establishing national drinking water-related policies and regulations related to microbial pathogens, disinfection byproducts, cyanotoxins, and PFAS. He has 14 years of experience at EPA; beyond SRRB, he has experience related to implementing EPA's drinking water regulations, storm water management, ballast water and vessel regulation, and managing inter basin water transfers. Ryan received his bachelor's degree at Emory University and his Ph.D. from George Mason University.

EPA's PFAS Team Lead: Hannah Holsinger (Holsinger.hannah@epa.gov)

Outline



What are Per- and Polyfluoroalkyl Substances (PFAS)?

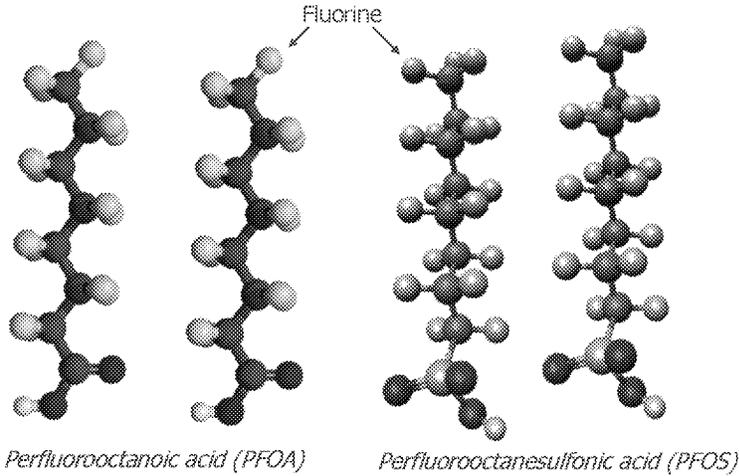


How are PFAS used?



What is EPA doing about it?

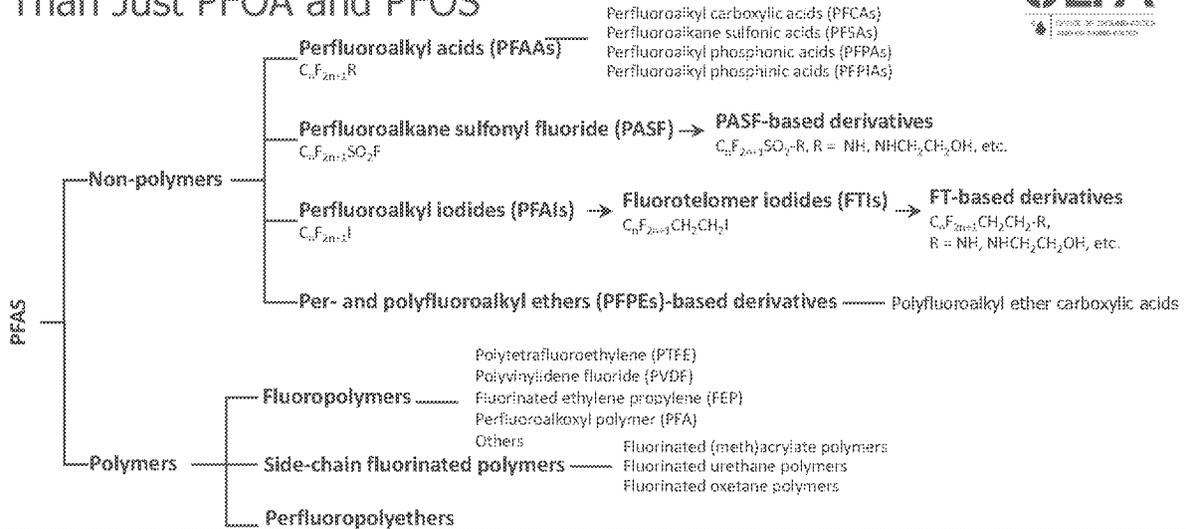
Per- and Polyfluoroalkyl Substances (PFAS)



A class of man-made chemicals

- Chains of carbon (C) atoms surrounded by fluorine (F) atoms
 - Water-repellent (hydrophobic)
 - Stable C-F bond
- Some PFAS include oxygen, hydrogen, sulfur and/or nitrogen atoms, creating a polar end.

PFAS: More Than Just PFOA and PFOS



PFOA = perfluorooctanoic acid – PFCA

PFOS = perfluorooctanesulfonate – conjugate base of PFSA

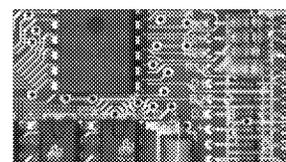
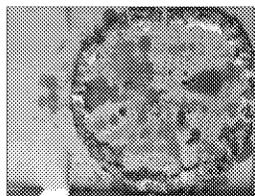
“Per” = fully fluorinated

“Poly” = many fluorines

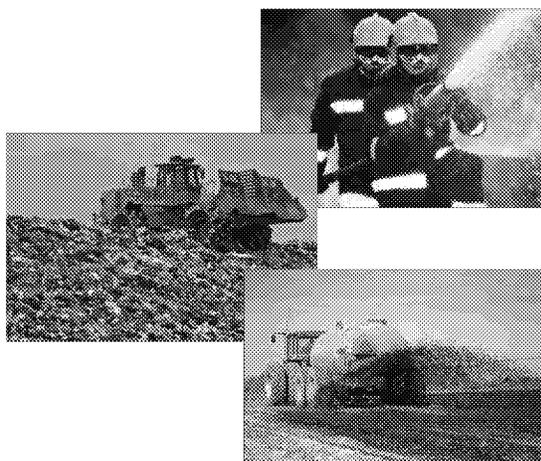
Used in Homes, Businesses & Industry



- Food contact surfaces such as cookware, pizza boxes, fast food wrappers, popcorn bags, etc.
- Polishes, waxes, and paints
- Stain repellants for carpets, clothing, upholstered furniture, etc.
- Cleaning products
- Dust suppression for chrome plating
- Electronics manufacturing
- Oil and mining for enhanced recovery
- Performance chemicals such as hydraulic fluid, fuel additives, etc.



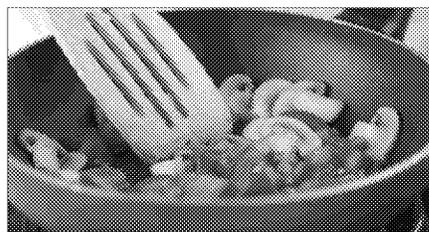
Sources of PFAS in the Environment



- Direct release of PFAS or PFAS products into the environment
 - Use of aqueous film forming foam (AFFF) in training and emergency response
 - Release from industrial facility
- Chrome plating and etching facilities
- Landfills and leachates from disposal of consumer and industrial products containing PFAS
- Wastewater treatment effluent and land application of biosolids

Potential Reasons for Concern

- Known or suspected toxicity
- PFAS and/or breakdown products are persistent in the environment
- Persistence in biota vary greatly across PFASs and species
- Used by a variety of industries
- Found in a variety of consumer products
- Most people have been exposed to PFAS



Dietary Exposure



- In areas where drinking water has been contaminated, ingestion is a primary route of exposure to PFAS.
- In some states, the consumption of certain types of fish and shellfish caught from contaminated bodies of water has led to public health advisories for some PFAS, particularly PFOS*.
- Some States such as New Jersey, Michigan, and Minnesota have guidelines for PFAS that provisionally recommend maximum frequencies at which specific fish species caught in those water bodies can be eaten with no adverse effects on health.
- Communities living on subsistence economy may not have food habits that reflect those of the general population.

*See summary: EPA 823-N-16-003, August 2016, *Fish and Shellfish Program Newsletter*

EPA's Current PFAS Activities



- **Issues related to PFAS involve most EPA Programs and Regions.**
- **Four broad goals:**
 - Fill data gaps related to human health toxicity to inform public concerns and risk mitigation
 - Establish validated methods for measuring many PFAS in different media
 - Reduce environmental exposures
 - Assure accurate and timely risk communications

EPA's PFAS Coordinating Committee

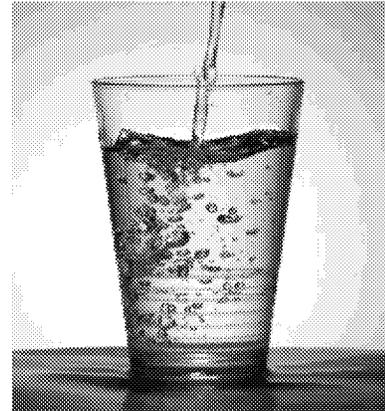


- **EPA announced cross-Agency effort to address PFAS in December 2017.**
- **Focus on near-term actions to support states, tribes and local communities, including:**
 - Fill data gaps related to toxicity of additional PFAS compounds
 - Develop analytical methods to expand the capacity for analysis of PFAS compounds in drinking water and other contaminated media
 - Provide treatability information for PFAS compounds in contaminated media
 - Expand tools for proactive risk communication with communities impacted by PFAS compounds
- **EPA's Office of Water is leading these efforts**
 - Includes members from EPA's air, chemicals, land, water, enforcement, and research offices as well as EPA regions to enhance cooperation with partners at the state and local level

Current PFAS Activities in Water



- **Published Drinking Water Health Advisories (HA) in 2016 for PFOA and PFOS**
 - HAs are non-regulatory information for federal, state and local officials to consider when addressing drinking water contamination.
 - Identified 0.07 $\mu\text{g/L}$ (70 ppt) as the HA level for PFOA and PFOS combined and provided information about treatment and monitoring.



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Current PFAS Activities in Water



- **Evaluating PFOA and PFOS for regulatory determination under the Safe Drinking Water Act (SDWA)**
 - PFOA and PFOS are on the fourth Contaminant Candidate List (CCL 4) published in November 2016. OW is assessing PFOA and PFOS against the three SDWA regulatory determination criteria.
 - *May have an adverse effect on the health of persons*
 - *Is known to occur or there is a substantial likelihood that it will occur in public water systems with a frequency and at levels of public health concern*
 - *In the sole judgment of the Administrator, regulating the contaminant presents a meaningful opportunity for health risk reductions for persons served by public water systems*
 - From 2013 to 2015, EPA collected nationally representative data on the occurrence of six PFAS in public water systems (including PFOA and PFOS).

Current PFAS Activities for Waste Sites



- **EPA Federal Facility Superfund Program**
 - Actively engaged PFAS activities at 58 Federal Facility NPL Sites
 - It is anticipated that this number will grow since there are known or suspected contaminations of PFAS at many of the 140 DoD Federal Facility NPL Sites.
 - PFAS detections in groundwater range from non-detect (based on analytical method limitations) or slightly exceeding the Drinking Water Health Advisory of 70 ppt (PFOA and PFOS combined) to 2,000,000 ppt.
 - Drinking water has been potentially impacted at 22 of these Federal Facility NPL sites.

Current PFAS Activities for Waste Sites



- **Office of Superfund Remediation and Technology Innovation (OSRTI)**
 - 29 known impacted non-Federal NPL sites
 - 100s of potential NPL sites (e.g., 100 metal plating sites, 300 landfills)

- **Regional Assistance**
 - OLEM offices hold site-specific consultations with EPA Regions on investigations of PFAS contamination
 - OSRTI/FFRRO provides ongoing technical assistance on PFAS issues and also coordinates with the Regions on their needs and priorities on PFAS issues
 - Develop cleanup recommendations for PFOA/PFOS contaminated groundwater

Current PFAS Activities in Chemical Use

- **PFOA Stewardship Program**

- Eight companies participated in the program and successfully eliminated production of PFOA.
- Resulted in phase-out of PFOA and related PFAS, including potential PFOA precursors, by these companies by the end of 2015.

- **EPA's New Chemicals Program**

- Since 2000, have reviewed hundreds of pre-market alternatives for PFOA and related chemicals.
- Most were approved with restrictions and data-generation requirements.

Current PFAS Activities in Chemical Use

- **Significant New Use Rule (SNUR)**

- Proposed on January 21, 2015, to require manufacturers, importers, and processors of PFOA and related chemicals (including as part of articles), to notify EPA at least 90 days before starting or resuming new uses of these chemicals in any products.
- Notification provides EPA opportunity to conduct risk assessment/management for the new use.

- **Gen X**

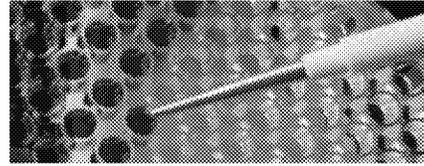
- EPA is revising the GenX risk assessment originally done for its pre-market approval, based on data received by the company and other information arising from the NC situation.

Current PFAS Research Activities



- **Human Health/Toxicity**

- Understand human health toxicity
- Inform risk mitigation activities
- Chemical library and high throughput toxicity testing

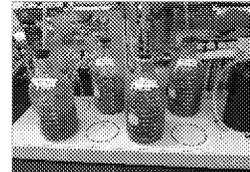


- **Analytical Methods**

- Establish validated methods for measuring PFAS in different environmental media

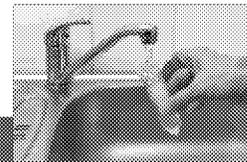
- **Site Characterization/Exposure**

- Develop sampling methods to characterize sources and contaminated sites
- Identify and estimate human exposure to PFAS from different sources



- **Treatment/Remediation**

- Identify/evaluate methods to reduce PFAS exposures
- Identify/evaluate methods to treat and remediate drinking water and contaminated sites



EPA's PFAS National Leadership Summit



- **Included representatives from over 40 states, tribes, and territories; 13 federal agencies; congressional staff; associations; industry groups; and non-governmental organizations.**
- **EPA provided the opportunity for the public to join in a portion of the meeting via streaming online and is asking the public to send written input to EPA.**
 - Visit <https://www.regulations.gov/> enter docket number: [OW-2018-0270](#)
- **During EPA's PFAS National Leadership Summit, participants worked together to**
 - share information on ongoing efforts to identify PFAS in communities and characterize risks from PFAS;
 - identify specific near-term actions, beyond those already underway, that are needed to address challenges currently facing states and local communities; and
 - develop risk communication strategies that will help communities to address public concerns with PFAS.

EPA's PFAS Summit/Engagement



- **EPA announced four actions the Agency will take following the Summit:**
 - EPA will initiate steps to evaluate the need for a maximum contaminant level (MCL) for PFOA and PFOS.
 - EPA is beginning the necessary steps to propose designating PFOA and PFOS as “hazardous substances” through one of the available statutory mechanisms, including potentially CERCLA Section 102.
 - EPA is currently developing groundwater cleanup recommendations for PFOA and PFOS at contaminated sites and will complete this task later this year.
 - EPA is taking action in close collaboration with our federal and state partners to develop toxicity values for GenX and PFBS.

EPA's PFAS Outreach and Engagement

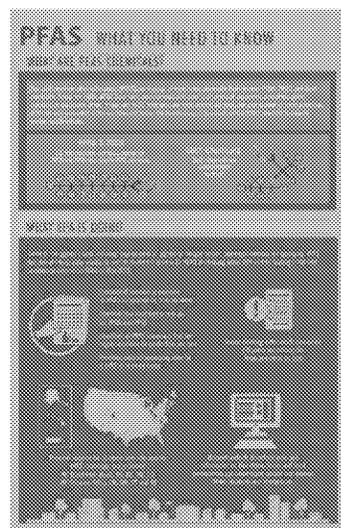


- EPA met with communities and tribes impacted by PFAS to further engage on ways the agency can best support work occurring at state, local and tribal levels.
- **Community Engagement**
 - June 25-26: Portsmouth, NH
 - July 25: Horsham, PA
 - August 7-8: Colorado Springs, CO
 - August 14: Fayetteville, NC
 - September 5: Leavenworth, KS
- **Tribal Engagement**
 - August 15: Spokane, WA
 - September 17: Mount Pleasant, MI
- **Site Visits and Roundtable**
 - October 4: Ann Arbor and Pinckney, MI
 - October 5: Parchment and Kalamazoo, MI
- EPA received over 118,000 comments from the public docket from citizens across the country and interested stakeholders.
- EPA plans to develop a PFAS Management Plan using information gained from the Summit, community engagements, and public docket.

Risk Communication



- **Case Studies**
 - In collaboration with ECOS and ASTHO, EPA worked with States to compile case studies of risk communication around PFAS.
- **EPA's PFAS Website**
 - One central location for information on PFAS and EPA actions to address PFAS
 - Infographic on PFAS and PFAS factsheet
 - Links to state programs and site-specific resources
- **Risk Communication Strategy**
 - Part of PFAS National Management Plan to help states, tribes, and local officials communicate PFAS issues to the public.



Minnesota's Perspective on PFAS

Minnesota has a relatively long history of addressing PFAS in drinking water. Minnesota public water systems (PWS) first monitored for and detected PFAS in 2004. This presentation will review the detection, risk evaluation, and treatment of PFAS at Minnesota PWS. Challenges and lessons learned about topics such as changing health-based values, lower detection limits, risk communication, and interagency collaboration will also be discussed.



Lucas Martin (lucas.martin@state.mn.us)

Lucas has served for 12 years as a District Engineer with the Minnesota Department of Health Drinking Water Protection Section. He conducts sanitary surveys and sampling for Community Public Water Systems in the east Twin Cities metro area, which includes communities affected by PFAS contamination. He is also involved in Minnesota's Contaminants of Emerging Concern program and is the state's coordinator for EPA's Unregulated Contaminants Monitoring. Lucas has a Bachelor's degree in Chemical Engineering from the University of Minnesota, and is a registered Professional Engineer in Minnesota.

Good afternoon.

Minnesota has a relatively long history of dealing with per- and polyfluoroalkyl substances (PFAS) in drinking water.

Thank you for the opportunity to describe Minnesota's PFAS experiences.

Topic

Background

Minnesota's PFAS Timeline

Health-Based Values

Response

Lessons Learned

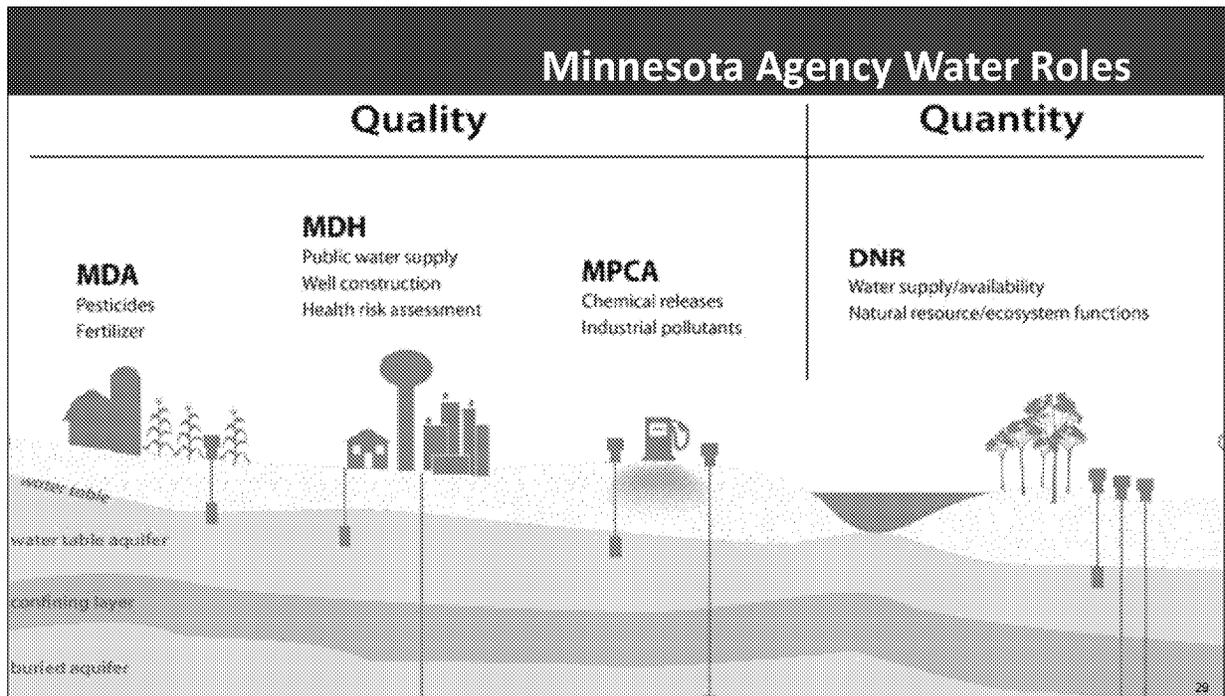
I'll start by providing some background leading up to the first Minnesota PFAS monitoring and detections in 2004, leading into a general activity timeline.

I'll summarize our health-based value scenarios, describe responses by affected PWSs and regulatory agencies, and then attempt to review lessons we've learned.

Minnesota Means Water



Minnesota, which is Dakota Sioux for “sky tinted water”, has abundant natural water resources. However, the 90,000 miles of shoreline and other water resources come with great responsibilities to protect them, especially as a Headwaters State.



At the state level, water quality and quantity are protected by several agencies:

For quality:

Minnesota Department of Agriculture (MDA): Mission is to enhance Minnesotans' quality of life by ensuring the integrity of our food supply, the health of our environment, and the strength of our agricultural economy.

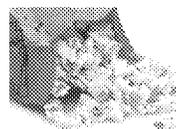
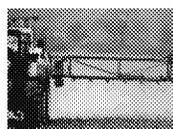
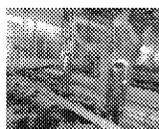
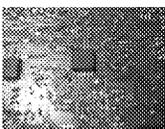
Minnesota Department of Health (MDH): Mission is to protect, maintain and improve the health of all Minnesotans.

Minnesota Pollution Control Agency (MPCA): Mission is to protect and improve the environment and human health.

For quantity:

Minnesota Department of Natural Resources (DNR): Mission is to work with citizens to conserve and manage the state's natural resources, to provide outdoor recreation opportunities, and to provide for commercial uses of natural resources in a way that creates a sustainable quality of life.

Per- and Polyfluoroalkyl Substances (PFAS)



- Family of many synthetic chemicals
- Developed and used since the 1940s
 - resist heat, stains, water, oil, grease
 - “non-stick”
- Production increased rapidly in the 1970s
- Persist in the environment, found everywhere

Source: open access images – bing.com

30

Increasingly, these agencies have been paying attention to per- and polyfluoroalkyl substances (PFAS). These chemicals were developed and produced by companies like 3M since the 1940s to make products that resist heat, stains, water, oil, grease, and to produce non-stick surfaces used on cookware and food packaging.

Production increased in the 1970s, along with use of products like Scotchgard and Teflon. This also included production of Class B “aqueous film forming foams”, which 3M and the U.S. Navy developed in the early 1960s for use on flammable petroleum fires.

PFAS are extremely stable and do not break down in the environment. They travel through soil and easily enter groundwater, where they can move long distances. Some studies have shown that they can also travel long distances in air.

PFAS can also be found in many species of wildlife around the world, including fish, eagles, and mink in the mid-western US.

Nearly all people have some level of PFAS in their blood, regardless of age. People are exposed through food, household dust, consumer products, and drinking water in some communities.

Timeline of PFAS Activities in Minnesota

1950s – 1970s

- Disposal of PFAS occurred at sites in Washington County
- No regulations at time of disposal

2000

- 3M began phase-out of PFOA/PFOS products

2002

- 3M informed State of MN of detections of PFOA/PFOS in production wells in Washington County
- MDH releases first health-based guidance values

31

From the 1950s through the early 1970s, 3M disposed of wastes from PFC manufacturing primarily at 4 dump sites in the East Metro of the Twin Cities, within Washington County. These dump sites are located in Oakdale, Woodbury, at a 3M manufacturing facility in Cottage Grove, and at the Washington County landfill. There were no regulations at that time related to disposal of these chemicals.

3M began phasing out PFOA/PFOS products in 2000.

In 2002, 3M informed the state of Minnesota about detections of PFOA and PFOS in production wells in Washington County. MDH then released its first health-based guidance values for drinking water.

Timeline of PFAS Activities in Minnesota

2002 – 2004

- Groundwater monitoring revealed PFOA/PFOS contamination at additional sites

2007

- MPCA and 3M agree to consent order

2010

- MN Attorney General files natural resource damage lawsuit on behalf of state

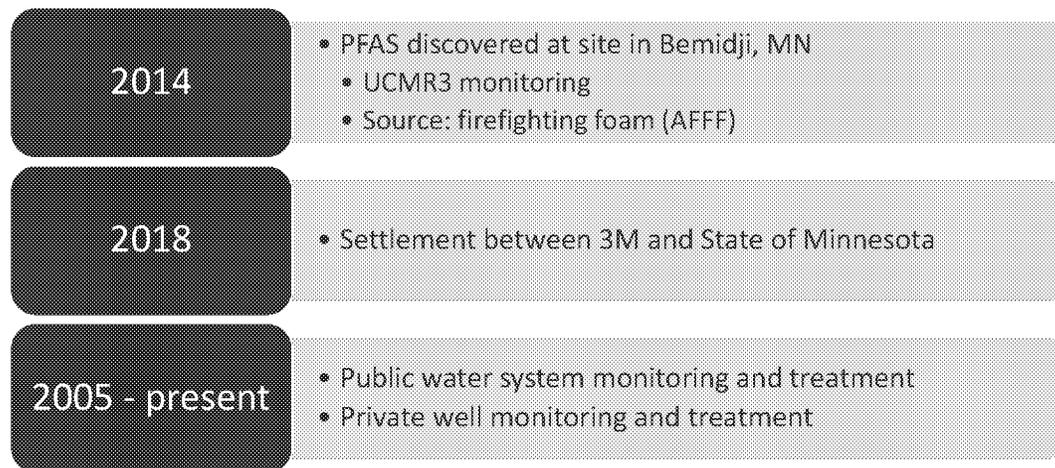
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Between 2002 and 2004, groundwater monitoring showed PFOA and PFOS contamination at additional sites.

In 2007, 3M and the MPCA agreed to a consent order, which outlines that 3M is responsible for:
providing safe drinking water to affected residents,
cleaning up PFAS waste disposal sites, and
monitoring groundwater

In 2010, the Minnesota Attorney General filed a natural resource damage lawsuit against 3M on behalf of the State.

Timeline of PFAS Activities in Minnesota



33

In 2014, the 3rd round of Unregulated Contaminant Monitoring Rule detected PFAS in the city of Bemidji's public water supply wells, which are located on the grounds of an airport. This contamination has been associated with the use of fire fighting foams during training exercises conducted at the airport.

This year, 3M and Minnesota reached a settlement in their natural resources lawsuit. More information about this settlement will be discussed later in the presentation.

Meanwhile, public water systems and private wells have continued to be monitored and treated since 2005.

We had looked in Bemidji earlier but didn't detect because of higher detection limits

LOCATION OF 3M SITES IN WASHINGTON CO. MINNESOTA

PFAS in Minnesota

- 4 PFAS disposal sites in Washington County
 - 3M made PFAS at its Cottage Grove facility in the early 1950s
 - PFOA was a primary product; some PFOS, PFBA and other PFAS
- Additional site in Bemidji
 - Firefighting foam

Geographically, the four Washington County sites where PFAS were detected between 2002-2004 are on the eastern side of the Twin Cities metro area.

Bemidji, the site of 2014 PFAS detection, is located northwest of the Twin Cities near the headwaters of the Mississippi River.

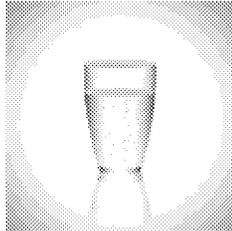
MDH Health-Based Guidance Values

PFOS:
0.027 ppb

PFOA:
0.035 ppb

PFBA:
7 ppb

PFBS:
2/3 ppb



- The concentration of a chemical (or a mixture of chemicals) that is likely to pose little or no risk to human health
- Based on potential health impacts; do not consider cost and technology of prevention and/or treatment
- Non-regulatory
- Protective for susceptible & highly exposed populations
- Protective for tap water used for drinking, cooking, showering, and other uses
- Based on animal studies showing slight liver and thyroid effects (adults) and immune system and developmental effects (infants/children)

36

Minnesota's PFAS health-based guidance values have evolved since 2002 to include 4 compounds with values shown here (PFBS 2=chronic, 3=subchronic)

Values are based on concentrations of chemicals likely to pose little or no risk to human health

They do not consider treatment costs, so therefore can be challenging for a water system to meet

They are not regulatory limits, but are protective for susceptible and highly-exposed populations

They are also protective for tap water used for drinking, cooking, showering, and other uses

They are based on animal studies showing slight liver and thyroid effects, pertinent to adults, and immune system and developmental effects

Breastfeeding can be a significant exposure pathway for PFHxS, PFOS, and PFOA.

Health Risk Index

- MDH evaluates the combined effects of PFAS: Health Risk Index (HRI)
 - Allows us to account for differing levels of toxicity in similar chemicals
 - HRI > 1 indicates a possible health risk from given chemical group
- Cumulative – additivity assessment of chemicals with similar health endpoints (e.g. liver)

$$\frac{[\text{PFBA}]}{\text{PFBA HBV}} + \frac{[\text{PFBS}]}{\text{PFBS HBV}} + \frac{[\text{PFHxS}]}{\text{PFHxS HBV}^*} + \frac{[\text{PFOA}]}{\text{PFOA HBV}} + \frac{[\text{PFOS}]}{\text{PFOS HBV}} = \text{Health Risk Index}$$

where [PFAS] = detected PFAS drinking water concentration in HBV units

*Currently using PFOS as an interim substitute

37

Since PFAS often occurs in mixtures, MDH evaluates the combined health effect through a Health Risk Index compared to a value of 1

This is an additive assessment of chemicals with similar health endpoints, currently expressed as a sum of 5 ratios of the detected concentrations divided by the Health Based Values for:

PFBA

PFBS

PFHxS

PFOA

PFOS

MDH is currently using the health based value for PFOS as a surrogate value for PFHxS, because studies show that they have similar half lives in the body and similar toxicity.

4717.7870 EVALUATING CONCURRENT EXPOSURES TO MULTIPLE CHEMICALS.

RiskNext from multiple chemicals detected in groundwater must be evaluated as specified in part 4717.7880 for effects other than cancer and in part 4717.7890 for cancer. If a chemical causes both cancer and effects other than cancer, the PreviousriskNext contributed by that chemical must be included in both evaluations. When the multiple chemical PrevioushealthNext PreviousriskNext PreviousindexNext is greater than one, the multiple chemical PrevioushealthNext PreviousriskNext Previouslimit has been exceeded.

Statutory Authority:

MS s 103H.201

History:

33 SR 1792

Published Electronically:

May 11, 2009

4717.7880 MULTIPLE CHEMICAL HEALTH RISK LIMITS: NONCANCER.

The procedures stated in the Health Risk Limits (HRLs) Rules for Groundwater for evaluating exposure to multiple chemicals are based on an additive model. The U.S. Environmental Protection Agency (EPA) uses this model as a reasonable approach given what is unknown about how chemicals interact in the body. Chemicals that share a common health endpoint are evaluated together.

For each chemical sharing a health endpoint, a ratio is calculated by comparing the groundwater concentration of the chemical to the exposure duration-specific health-based guidance for that chemical. The ratios are grouped by duration and summed within each health endpoint group.

To determine whether the sum exceeds the multiple-chemical health index of one for noncancer, the chemicals are grouped according to their noncancer health endpoints, e.g., liver, kidney, nervous system.

Risk Assessment and Water Guidance

PFAS	Health Endpoints		PFOA	PFOS	PFBA	PFBS	PFHxS
<u>PFBA</u>	Liver and thyroid	2002	7	1			
<u>PFBS</u>	Developmental, female reproductive system, kidney, and thyroid [blood system & liver no longer listed]	2006	1	0.6	1		
<u>PFHxS</u>	(see PFOS)	2007	0.5	0.3	7		
<u>PFOA</u>	Developmental, liver, immune system, and kidney	2009	0.3	0.3	7	7	
<u>PFOS</u>	Developmental, liver, immune system, and thyroid	2013	0.3	0.3	7	7	0.3
		2016	0.07	0.07	7	7	0.07
		2017	0.035	0.027	7	3/2	0.027
		2018-19		under review			under review

More information can be found at: <http://www.health.state.mn.us/divs/eh/risk/guidance/gw/table.html>

38

PFAS effects are researched very actively, with 50 – 80 publications in PubMed per month.

This, combined with the number of compounds and variety of health endpoints has resulted in a continuously changing set of drinking-water targets.

MDH has revised guidance values 2 – 4 times as scientific knowledge has changed.

All guidance values (given in ppb in the chart shown) were re-evaluated in 2017 & all but PFBA were lowered due to new information.

The PFOS and PFHxS health-based guidance values are currently under review, and we expect to complete these reviews within the next few months.

Changing guidance values have presented a challenge. We have presented a moving target to PWSs. Challenge with changing science, as we learn more about these chemicals.

Guidance – all were re-evaluated in 2017 & all but PFBA were lowered due to new tox and/or expo information. Currently these are all HBVs, however, PFOA and PFBA are in a HRL rules revision effort and should be HRLs later this year. PFOS and PFBS will be taken through the next rules revision. PFHxS – may be in next rules revision, depending upon quality of data.

* - PFOS values used as a surrogate for PFHxS in evaluation of health risk from PFHxS ** - Good Cause Exception HRL

*** - HAs for PFOS and PFOA are additive (combined concentration should be < HA) ^ - UCMR3 data collected from

2013-2016 # - lower value reflects change in PHL reporting limits in late 2016 HBV - MDH Health Based Value HRL -

MDH Health Risk Limit PHA - EPA Provisional Health Advisory HA - EPA Lifetime Health Advisory NA - not applicable,

UCMR3 did not include PFBA

The PFOS and PFHxS health-based guidance values are currently under review due to new information.



MPCA and MN DNR were both parties in the lawsuit against 3M, and are trustees for settlement funds, but many parties have roles in response to PFAS contamination

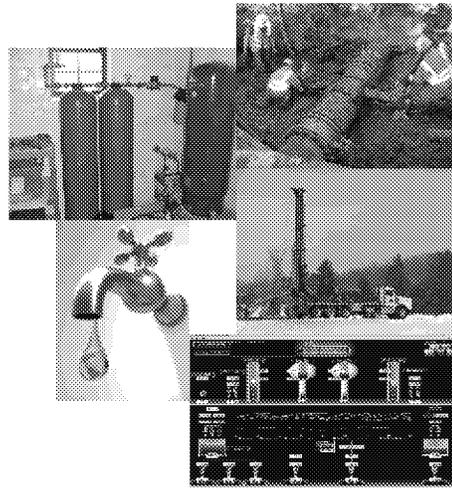
They include local governments such as Washington County and municipalities, as well as their public water systems. They have all had to collaborate on communicating with the general public, elected officials, and media

Washington County has...

Public water systems and local governments have had to determine what actions, if any, to take to treat drinking water. These entities have all collaborated on communicating with the general public, elected officials, and the media.

Response Options

- Regional interconnect
- New treatment facilities
- New wells
- Water conservation; limit use of contaminated wells
- Adapted blending scheme
- Others?



40

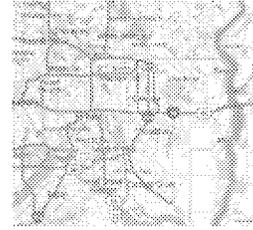
A variety of response options have been considered in the past, and will continue to be explored under the 3M settlement. They include but are not limited to interconnections, treatment, new wells, water conservation, and blending.

5 of the 8 affected communities have seen PFAS levels high enough to proceed along one or more of these approaches, and I'll briefly summarize them now:

Options systems have considered in response to PFAS. Will continue to be considered under settlement.

Oakdale (27,973)

- 9 wells; PFAS exceeds MDH health-based guidance value in 7 wells
- PFAS concentrations
 - highest in the state for community systems
 - PFOA: 0.440 ppb maximum
 - PFOS: 0.610 ppb maximum
- Treatment (GAC) installed in 2006 for 2 wells; carbon replaced annually
- Primarily rely on 2 treated wells and 2 “clean” wells for water supply
- Video: <http://bit.ly/2rWs9z5>
 - Youtube: “Invisible Heroes Oakdale”



41

Oakdale serves close to 28,000 people from 9 wells, 7 of which are impaired by PFAS

They've had the highest PFAS levels in Minnesota among community PWSs

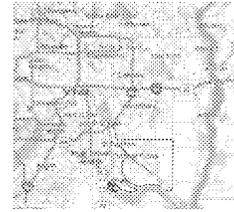
They installed GAC treatment in 2006 for 2 wells and replace the carbon annually

They rely on the 2 treated wells and 2 clean wells as their primary sources of water, which account for about 89% of their annual water production. The rest comes from occasional use of contaminated wells, and the water from those wells is blended with treated water.

Those interested in learning more about Oakdale's experience can watch a short video at the link shown here, or by searching "Invisible Heroes Oakdale" on youtube.

Cottage Grove (36,492)

- 12 wells; PFAS exceeds MDH health-based guidance in 8 wells
- PFAS concentrations
 - PFOA: 0.066 ppb maximum
- Impacted when health-based guidance values lowered
- Installed GAC treatment on 2 wells in 2017
- Directly blend 7 wells to manage concentrations
- Temporary watering ban in 2017 after receiving health advisory letter from MDH and prior to treatment



42

Cottage Grove serves about 36,000 people from 12 wells, 8 of which are PFAS impaired

PFOA is the primary compound of concern

The lowering of health-based guidance prompted them to install GAC treatment on 2 wells in 2017

They currently blend 7 wells, but initially banned watering in 2017 while waiting for treatment to go online.

Has 12 wells; 8 with PFAS exceeding MDH health-based guidance values

PFAS concentrations: no PFOS, 66 ppt PFOA

Impacted when health-based guidance values lowered

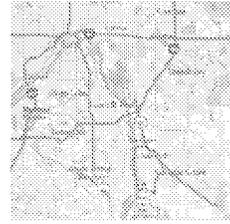
Installed GAC treatment on 2 wells in 2017

Have a direct blending point for 7 wells that can manage concentrations

Temporary watering ban in 2017 after receiving health advisory letter from MDH and prior to treatment

Saint Paul Park (5,519)

- 3 wells; PFAS exceeds MDH health-based guidance in 2 wells
- PFAS concentrations
 - PFOA: 0.043 ppb maximum
- Impacted when health-based guidance values lowered
- Planning to install treatment for all 3 wells in 2019
- Managing pumping so clean well is used the most, and enforcing watering restrictions



43

Saint Paul Park serves 5,500 people from 3 wells, 2 of which are PFAS impaired

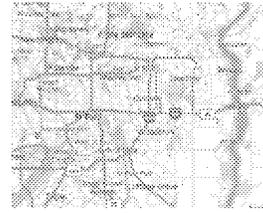
PFOA is the compound of concern

Lowered health based guidance has caused them to explore treatment while managing pumping to use their clean well most

They also have restricted watering.

Lake Elmo (4,878 / 8,069)

- Has 3 wells with 1 exceeding MDH health-based guidance values
- PFAS concentrations: no PFOS, 46 ppt PFOA
- Impacted when health-based guidance values lowered
- Contaminated well was taken offline in 2018
- Options for new well limited by water quantity issues



44

Lake Elmo serves about 5,000 people from 3 wells, 1 of which is PFAS impaired
PFOA is the compound of concern

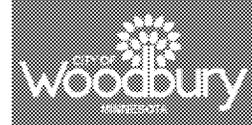
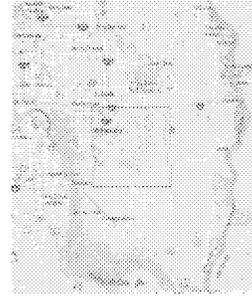
They took the contaminated well offline earlier this year due to the lowered health based guidance values

They have explored a new well, but that option is limited due to their proximity within 5 miles of White Bear Lake, which has had recent, extremely low levels that led to a legal settlement and a ban on well drilling within 5 miles of the lake.

Options for new well limited by White Bear Lake water level situation (5 mile radius)

Woodbury (69,245)

- 19 wells; PFAS exceeds MDH health-based guidance values in 5 wells
- PFAS concentrations
 - PFBA: 0.41 ppb maximum (all wells)
 - PFHxS: 0.07 ppb maximum (1 well)
 - PFOA: 0.049 ppb maximum (8 wells)
 - PFOS: 0.026 ppb maximum (3 wells)
- Primarily rely on wells that meet MDH health-based values for water supply. Others are used only seasonally to meet peak demand.



45

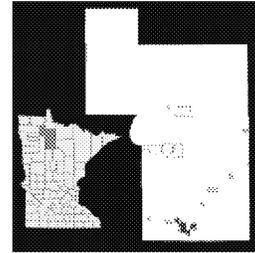
Woodbury serves 69,000 people from 19 wells, 5 of which are PFAS impaired

Four compounds play roles in this scenario

The city is currently able to rely on wells that are not impaired, but must occasionally activate others with PFAS to meet seasonal peak demands during the summer months.

Bemidji (14,942)

- 5 wells; PFAS exceeds MDH health-based guidance values in 4 wells
- PFAS concentrations
 - PFOS: 0.37 ppb maximum
 - PFHxS: 0.57 ppb maximum
- Source: firefighting foam – city responsible party
- PFAS discovered through UCMR3 monitoring
- All affected wells within city's airport and go to combined discharge – currently using 2 by blending
- Evaluating options – wells, treatment, new well field



46

Outside of Washington County,

Bemidji serves close to 15,000 people from 5 wells, 4 of which have exceeded PFAS guidance due to firefighting foam use

PFOS and PFHxS are the relevant compounds

They currently blend 2 wells from the affected airport well field with their clean well, while evaluating options for new wells or treatment

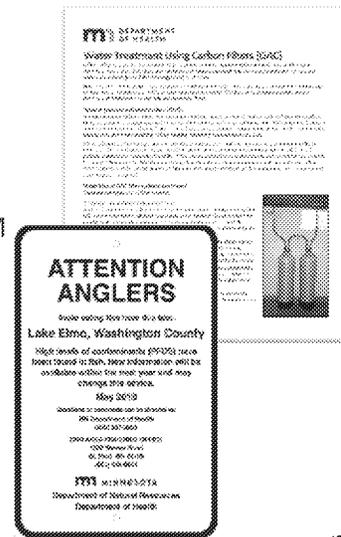
is different from the other sites – PFAS from firefighting foam use.



From the community perspective, however, these situations and their responses are highly visible, controversial, and present plenty of targets for criticism

Other PFAS Activities

- Private well sampling
 - >1,500 private wells sampled since 2003
 - >800 drinking water advisories issued
 - Homeowners provided in-home treatment funded by 3M
- Water filtration testing
 - GAC, RO, POU
- Fish consumption advice
 - Recommendations on how often to eat fish from certain waters



48

In addition to community-scale drinking water interventions, a number of other PFAS activities are ongoing:
Private well surveillance efforts have reached over 1,500 residential wells since 2003, resulting in over 800 advisories with 3M-funded in-home treatment options
Water filtration testing has generated reports on GAC and RO POU devices for residential use
Fish consumption advice has been developed to provide recommendations on fish consumption frequency from certain waters, namely Lake Elmo

Source:

<http://www.health.state.mn.us/divs/eh/hazardous/topics/pfcs/index.html#responseaffected>

Other PFAS Activities

- PFAS in Homes and Gardens study (2010)
 - Tested water, soil, produce and dust at 20 homes with PFAS in water
 - PFBA found in 98% of produce
 - No health risks of concern when considering all exposures
- Biomonitoring
 - Measured blood levels of 8 PFAS chemicals in two groups of East Metro residents
 - Levels were highest in those who lived longest in the area before treatment was installed



49

MDH started a study of PFC levels in homegrown produce, garden soil, and outdoor tap water from the eastern Twin Cities area in 2010.

Water, soil, dust, and produce were tested at 20 homes with PFAS in their water

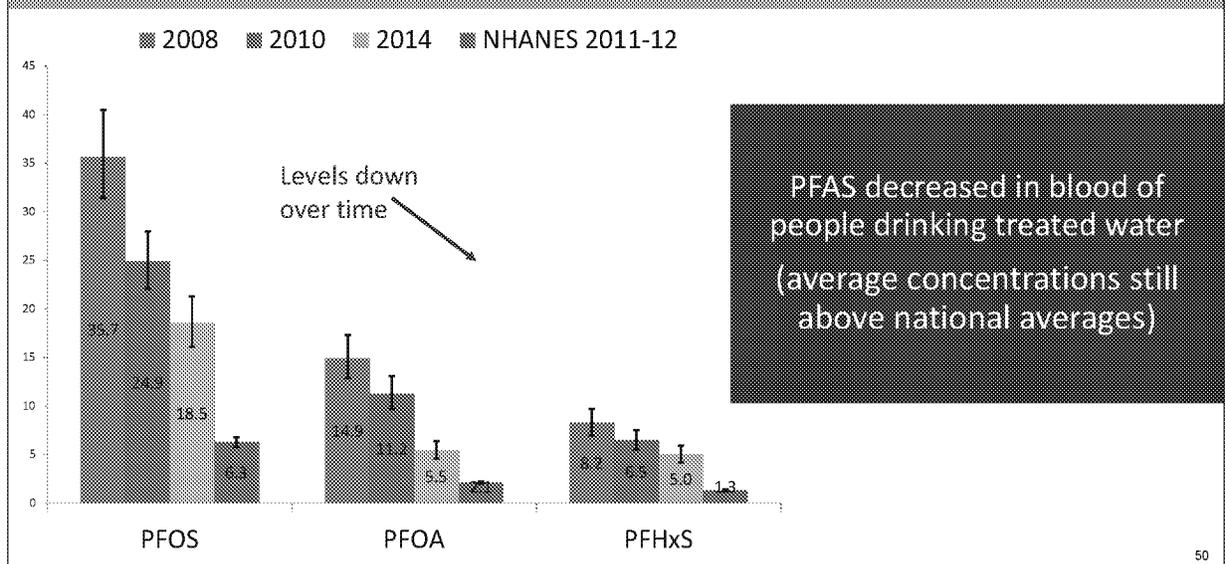
Short-chained PFAS, specifically PFBA, was found to be most prevalent in produce

Overall, no health risks of concern were found for anyone living in these communities when considering combined risk from all exposure pathways.

Since 2008, MDH has tracked blood levels of perfluorochemicals (PFCs) in people who live in the East Metro as directed by the Minnesota Legislature.

Levels were highest in those who lived longest in the area before treatment was installed.

Biomonitoring During Response



Biomonitoring results indicate downward trends in blood serum PFAS levels among those drinking treated water in Oakdale since the treatment plant went online.

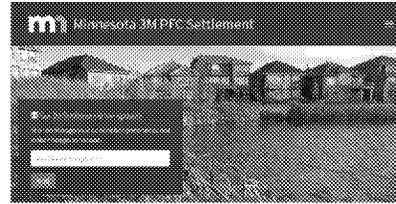
However, the averages, shown here in micrograms per liter of blood, are still above the national averages.

are geometric means in microgram of PFC per liter of blood.

U.S. population levels are from the 2011-12 National Health and Nutrition Examination Survey, which measures chemicals in a group of people 12 and older that represents the U.S. population.

2018 Minnesota 3M PFC Settlement

- \$850 million grant to the state
- Trustees: Minnesota Pollution Control Agency and Minnesota Department of Natural Resources
- \$720 million to provide long-term solutions for:
 - Clean and sustainable drinking water
 - Restoration and enhancement of natural resources
- Expectations for community participation
- Preserves 3M's obligations under the 2007 consent order



More information can be found at <https://3msettlement.state.mn.us>

51

Earlier this year, a settlement was reached in a lawsuit between 3M and the State of Minnesota.

A total of \$850M was granted to state trustees MPCA and DNR, which provides \$720M after legal fees and other expenses to be used for long-term solutions, with the first priority being to provide clean and sustainable drinking water to communities affected by the PFAS contamination in the East Metro area. \$40 million will also be immediately available for restoration and enhancement of natural resources, and any money remaining after ensuring safe drinking water will also be used for this purpose.

Community participation is expected, as are continuation of 3M's original 2007 consent order obligations.

More detailed information about this settlement can be found at the website shown at the bottom of this slide.

MDH was not part of the lawsuit (because it was about natural resource damages), so we are not a trustee of the funds

Lessons Learned

- Lack of federal maximum contaminant limit (MCL) means state has to decide how to act and regulate.
- Collaboration is important
 - Different parties may have different priorities
- Evolving health information makes it difficult for communities to plan for long term solutions.



So, What have we learned?

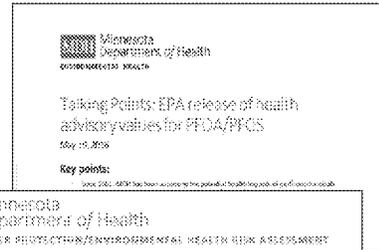
Minnesota has been obligated to act and potentially regulate due to the void of federal limits

Collaborations between different parties is important

Evolving health information makes dealing with this problem like trying to hit a moving target

Lessons Learned

- Communication is key
 - Must include the public, regulators, regulated parties, and elected officials
 - Not an emergency; PFAS health effects are based on a lifetime of exposure
 - State government regulators must give cities time to prepare a response
 - Unique risk communication challenges



53

Maybe the most important lesson learned is that communication is key:

Must include the public, regulators and those regulated, and elected officials – done through well planned public meetings

Not an emergency; PFAS health effects are based on a lifetime of exposure and are not acute

State government regulators must give cities time to prepare a response and develop their own communications plan before issuing a press release

Each scenario will present unique risk communication challenges

- Will continue to see changing health-based guidance values
- Will see broader analytical methods
 - Will be able to detect more PFAS chemicals
- How to spend \$720 million
 - Open houses and working groups to identify potential projects



Going forward, we will continue to see changing health-based guidance values, as well as new values. Our laboratory will use broader analytical methods and be able to detect more than the 7 PFAS currently detectable. The \$720M from the MN-3M Settlement will require a large scale effort and collaboration between many different units of government to make sure the money is used for projects that provide the greatest long term benefit to all affected communities.

Photo from July 2018 PFAS public meeting in the city of Oakdale



Through all of this, we're working together toward a goal of providing safe drinking water for everyone, everywhere in Minnesota

Treatment Options for PFAS in a Surface Water Treatment Plant

This presentation will focus on the results of a 12-month long pilot test of PFAS treatment options at a surface water treatment plant. The pilot test focused on the effectiveness of Granular Activated Carbon (GAC) and Ion Exchange (IX) for the removal of PFAS compounds and developing design criteria for full-scale treatment facilities from the pilot test results. The presentation will also review the site-specific economic analyses for GAC, IX, and RO, and the selected treatment strategy.



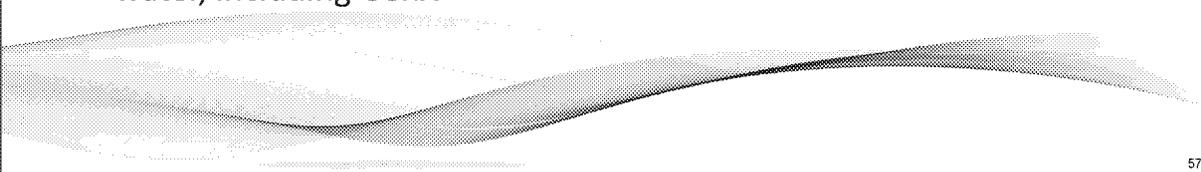
Carel Vandermeijden (carel.vandermeijden@cfpuu.org)

Carel is the Director of Engineering for the Cape Fear Public Utility Authority (CFPUA) in Wilmington, North Carolina. He is responsible for the day-to-day activities of the Engineering Department, including the development and implementation of the Authority's Capital Improvement Program for water and wastewater infrastructure. Carel has over 34 years of water and wastewater utility experience and is an active member of American Water Works Association and the Water Research Foundation. Prior to joining CFPUA, Carel was the Chief Engineer for the Greater Cincinnati Water Works.

Cape Fear Public Utility Authority



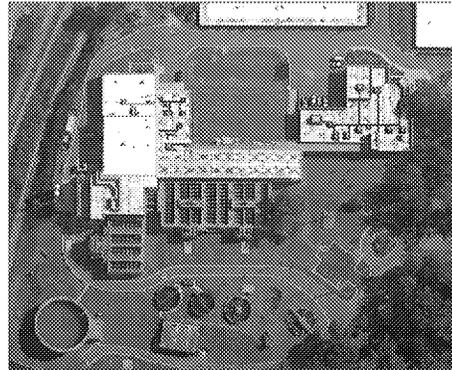
- Located in Wilmington, North Carolina
- 200,000 customers
- Two groundwater systems (7 mgd)
- One surface water system (35 mgd) - Cape Fear River raw water supply
- Per- and Polyfluorinated compounds (PFAS) detected in source and drinking water, including GenX



Existing Sweeney Water Treatment Plant



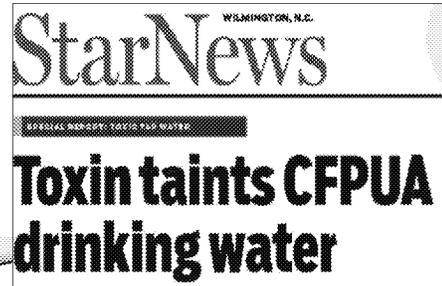
- Conventional treatment
- Raw water ozonation
- Pre-filter ozonation
- Biofiltration with GAC
- UV
- Chlorine disinfection
- More advanced treatment methods required for PFAS



Per-Fluorinated Compounds in the Cape Fear River



- June 2017 - *Wilmington StarNews* article on the presence of GenX in the Cape Fear River and in CFPUA drinking water.
- GenX is only about 12% of all PFCs quantified in source water.
- No MCL for GenX or other PFAS.
- NC-DHHS issued a preliminary health advisory level of 140 ppt for GenX.
- Customer Concerns:
 - Thousands of calls from concerned customers.
 - Numerous public forums, media interviews. Weekly press releases by CFPUA.
 - 9,800 people are members of the on-line “North Carolina Stop GenX in our Water” community organizing group.
 - Awareness of emerging contaminants has decreased consumer confidence in drinking water.
 - Utilities (ratepayers) should not bear the cost to address source water contamination by others.

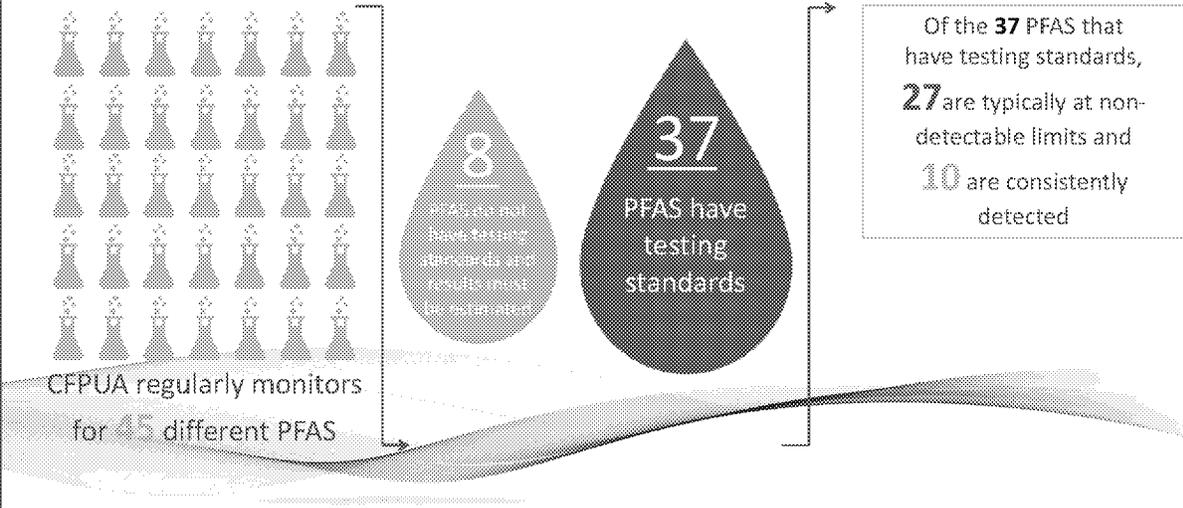


CFPUA Action on PFAS — 14 Months

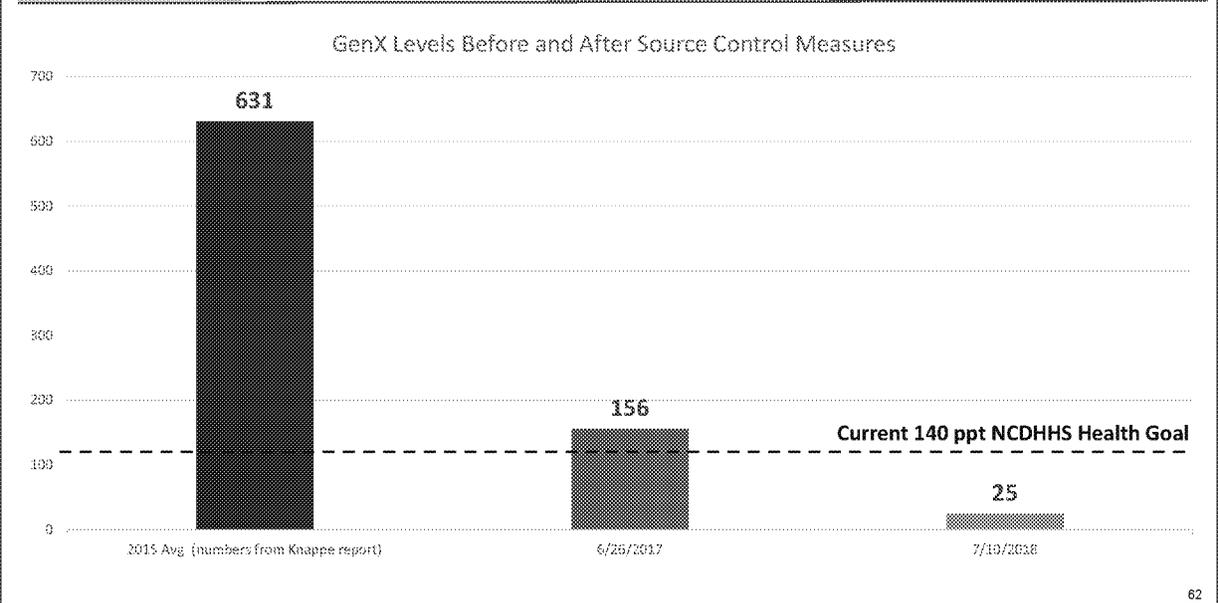


- For over one year, we have worked on the issue of GenX and other PFAS compounds.
- We have:
 - Worked with UNCW to identify new compounds.
 - Worked with NCDEQ to remain informed on regulatory actions.
 - Worked with NCDHHS to understand the health impacts.
 - Continuously monitored levels of PFAS in drinking water.
 - Taken legal action against Chemours.
 - Set up free water stations in our groundwater areas.
 - Conducted a full pilot study to investigate treatment options.
 - Removed 50 million gallons from the Aquifer Storage and Recovery site.
 - Participated in interviews, forums and industry conferences to share our experience with regulators, utilities and the public.

Testing for PFAS in CFPUA Service Areas

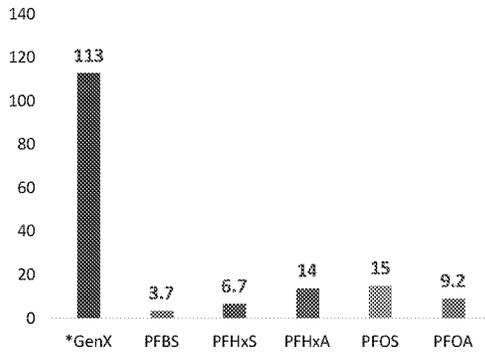


Source Control Shows Success with GenX

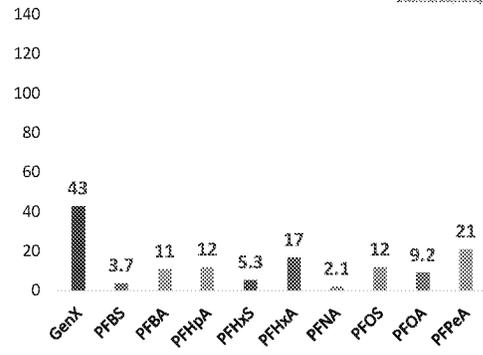


Health goal was 70,000 ppt. 631 average and do an asterick showing the maximum detected.

GenX Levels are Down, Other PFAS Remain: Is Remediation Needed?



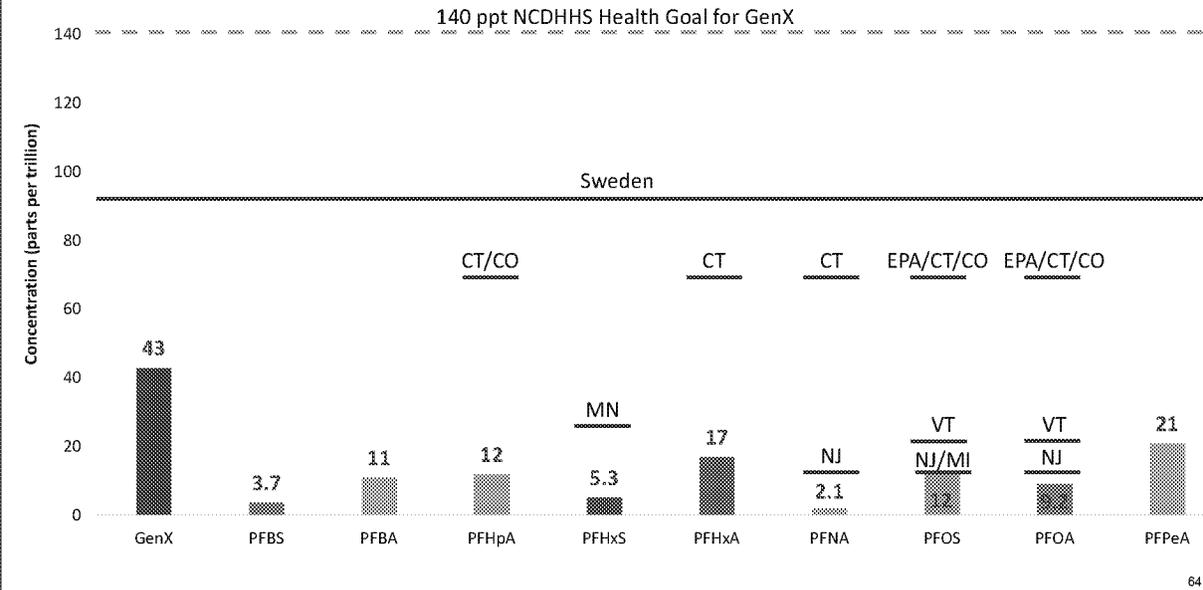
July 2017



June 2018

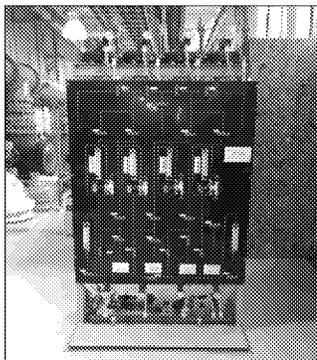
*Levels of compounds are measured in parts per trillion (ppt)

What Are the Existing Health Goals for PFAS?



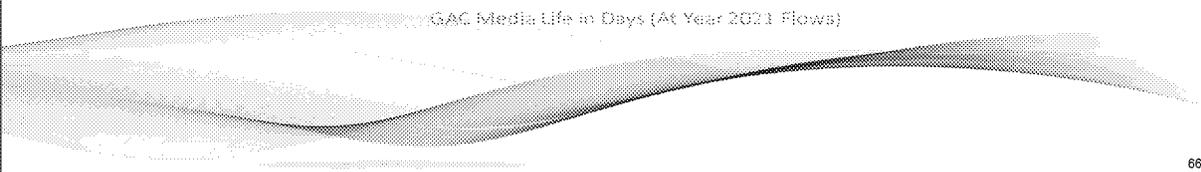
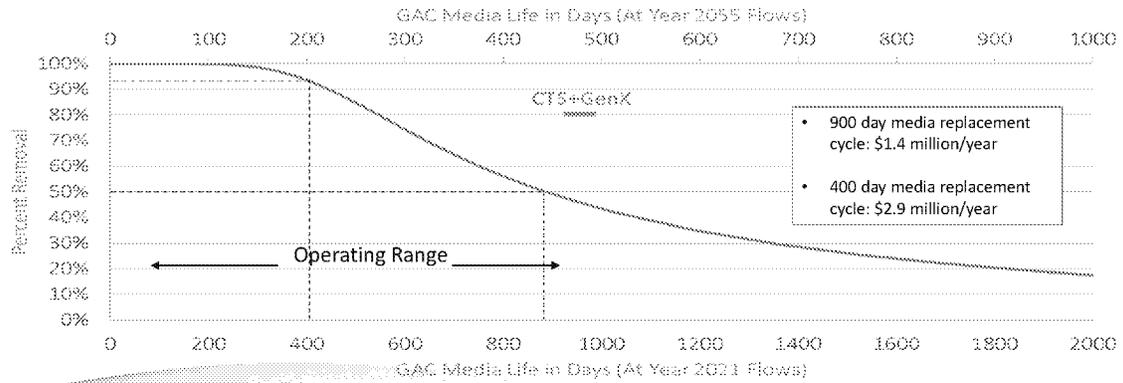
Should we move to regulatory section?

Completed Pilot Testing to Select PFAS Treatment Options

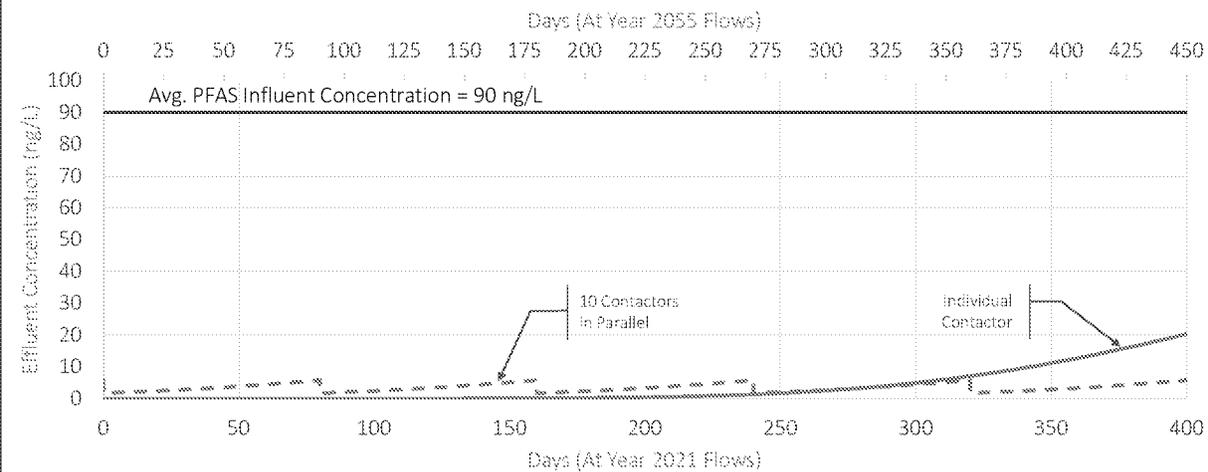


- Technologies Considered
 - Granular Activated Carbon
 - Ion Exchange
 - Reverse Osmosis
- Operational Strategies
- Criteria for Full Scale Design
- Considerations
 - Removal Rates
 - Environmental Impacts
 - Rate Impacts and Cost
- Secondary benefits if implemented for PFAS treatment

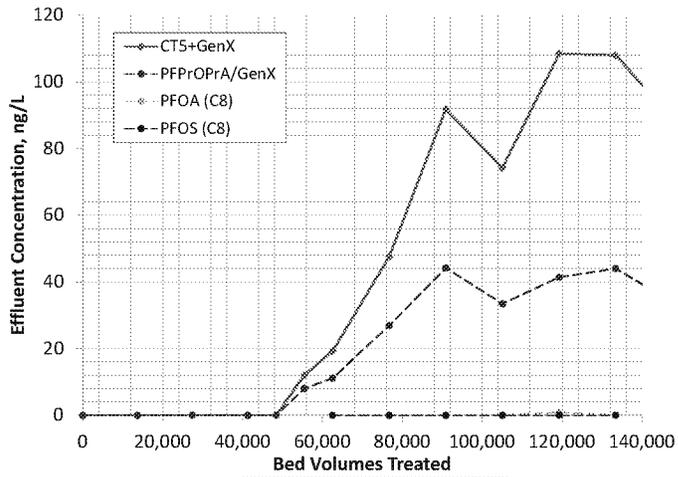
Life of GAC Media: When Do GenX and the "Connecticut Five" PFAS Begin to Breakthrough?



GAC Replacement Cycle at 400 Days Runtime



IX Performance



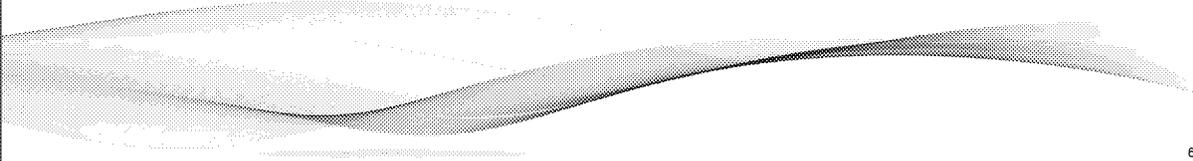
GAC is still the best treatment solution for the Sweeney WTP AND allows for transition to IX to address possible more stringent limits in the future.



Considerations for Selecting Treatment Process



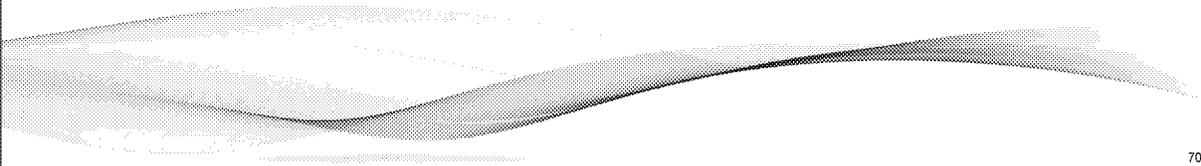
Consideration	Granular Activated Carbon	Ion Exchange	Reverse Osmosis
Treatment			
• PFAS removal	Effective towards PFAS reduction	Effective towards PFAS reduction	Provides broad removal of all varieties of PFAS
• Flexibility	Can be modified to adapt to changes in regulations	Limited flexibility.	Limited flexibility because RO provides broad removal
• Corrosion control	Consistent with existing corrosion control program	Consistent with existing corrosion control program	Requires additional treatment to prevent lead and copper corrosion
Environmental	Removes PFAS from the environment	Filter media must be disposed of, cannot be destructed like carbon	Greater waste stream with low concentrations of PFAS loads to Cape Fear River (NPLUS Permit required)



Financial Comparison to Reduce PFAS at the Sweeney Water Treatment Plant



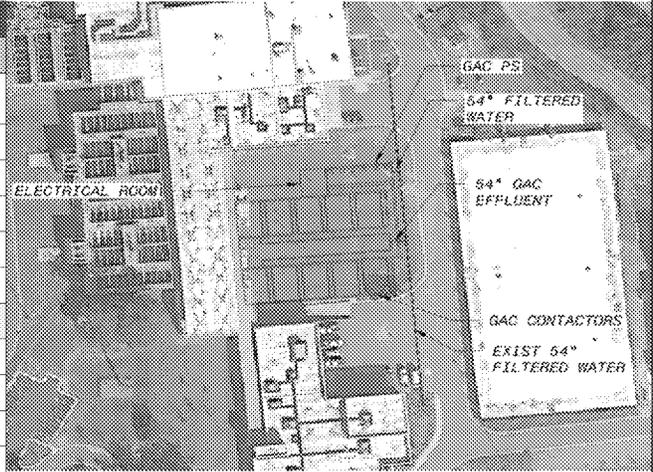
	GAC	RO
Capital Costs	\$46,000,000	\$150,000,000
Annual Operating Costs	\$2,900,000	\$4,700,000
Lifecycle Net Present Value	\$215,000,000	\$504,000,000



Conceptual GAC Facility

Deep Bed GAC Contactors Design Summary

Contactors	
Quantity	10
Design Flow Rate, gpm (ea)	3,056
Type	Concrete Basin
Length (ea), ft	22
Width (ea), ft	37.6
Area (ea), sf	827
Media, per contactor	
Bed Depth, ft	10
Max Loading Rate, gpm/ft ²	4.1
EBCT, min	20
Bed Volume, cf (ea)	8,272



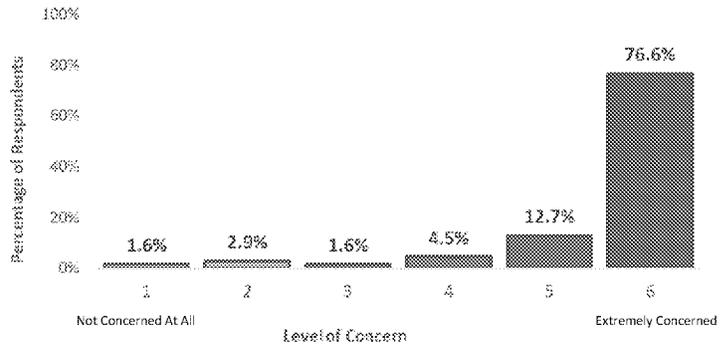
Customer Survey: Significant Trends



Question 4

On a scale of one to six, rate your level of concern about GenX.

- 89.3% of respondents are concerned or extremely concerned about GenX.



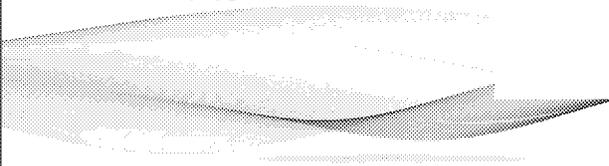
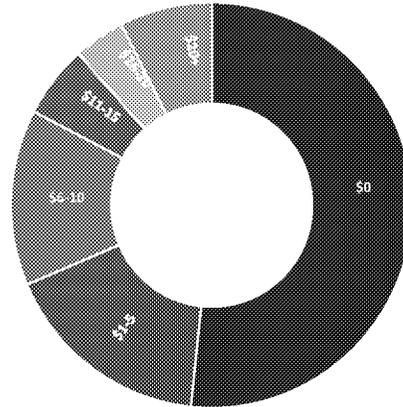
Customer Survey: Significant Trends



Question 6

Select the most (per bimonthly bill) that you are willing to pay in addition to your current charges for the CFPUA plant upgrade.

- Of customers that responded "\$0":
 - 83% responded that they were extremely concerned about GenX.
 - Many believe Chemours should be the organization that pays for an upgrade.
- 48.45% of respondents were willing to pay between \$1-\$20+ per bi-monthly bill for a Sweeney upgrade.



Questions and Answers Session

